Remarks by the Honorable Michael D. Griffin
NASA Administrator
Moe Schneebaum Memorial Lecture
NASA Goddard Spaceflight Center
Greenbelt, Maryland
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I'm honored that you have invited me back to present the Moe Schneebaum Lecture for a second time. Mary Cleave an old, old friend invited me some years ago to give the Schneebaum lecture I enjoyed that, and I will enjoy doing it again.

I am delighted to extend my congratulations to this year's Schneebaum award recipient, Dr. Jentung Ku. I need you to send me an introductory paper on how your capillary heat transfer approach works, because that will have to go into the next edition of my book. It's not there now. And it needs to be clearly. So I'm very pleased to hear about your award and your work.

Dr. Ku's trailblazing work on two-phase thermal control systems has greatly enhanced a number of our Earth science missions: TERRA, ICESAT, AURA, SWIFT and GOES N-Q, as well as the Hubble Space Telescope, and I'm told also some other missions.

We are very fortunate that Dr. Ku continues to apply his expertise on developing miniature two-phase systems for small spacecraft missions and developing cryogenic two-phase systems for future large observatories. There are certain technologies that are on the critical path for achieving important agency objectives, and Dr. Ku has made seminal contributions to NASA's work in one of those areas. The basic physics of signal collection guarantee that highly efficient cooling systems will always be important to NASA. So it's fundamental work. It's not just nice to have.

Through his achievements, our award winner is certainly carrying on in the tradition of excellence established by Moe Schneebaum, one of NASA's most distinguished engineers. A long time ago, the poet Henry Wadsworth Longfellow observed, "The lives of great men remind us that we can make our lives sublime, and departing, leave behind us footprints on the sands of time." Moe Schneebaum's life was relatively brief—53 years—but through his dedicated work he left behind some rather enormous footprints.

His pioneering work on the development of cameras for our first weather satellites and advanced sensing instruments for Landsat and Nimbus serve as an example of what creative, visionary engineers can accomplish over the course of their careers.

Schneebaum's work in turn carried on the legacy of Robert Goddard whose incredible career exemplified the importance of having a vision and sticking to your guns when everyone around you is skeptical. One of my favorite stories concerns the famous New York Times editorial opining that Professor Goddard was a fool for pursuing the notion that rockets could fly in the vacuum beyond Earth's atmosphere. In their view any fool should know that in space there is nothing to push against. They were not alone in this criticism, but Goddard persevered despite being an object of great public derision because he knew that he was right. Of course the New York Times eventually got around to printing a retraction on the day that Apollo 11 landed on the moon. (Laughter) All true. The problem is I'm old enough that I remember the retraction quite well.

A New Generation of NASA Engineers

I am, however, getting to be in the minority, as today, with one-fourth of NASA's engineering workforce about to become eligible for retirement in the next five years, we will need to pass the torch of leadership to a new generation of Goddards, Schneebaums and Kus.

I hope those of you who are just starting your careers are most eager to carry the torch, as you will have the opportunity to tackle the most rewarding engineering challenges that a bright young engineer could imagine.

Engineering Challenges for Goddard

Here at Goddard, for example, you will face new challenges in the way we approach our robotic spacecraft in the future. We have developed a tremendous system of Earth monitoring satellites with the help of people like Jentung and Moe Schneebaum. Imagine how much powerful our Earth observing satellites, and for that matter our astronomical observatories and planetary spacecraft can be if we device an interplanetary internet system to instantaneously link data from all these spacecraft to a scientists' computer. Imagine if you could click on an IP (Internet Protocol) address and pull up any spacecraft that you want to.

The skills demonstrated by Goddard in managing the space network and relay satellites that support our network of Earth observing satellites will also be called upon do develop an interplanetary internet system to link humans and machines as they expand through the solar system.

In a few decades, the search for life beyond our world, and beyond our solar system, will be carried out by large space telescopes capable of imaging the atmospheres of planets orbiting distant stars. Our next generation of engineers will be challenged to create sophisticated astronomical instruments that will be assembled in space, at sights such as Sun-Earth L-2 (Lagrange Point), with a combination of human and robotic assembly. The crew exploration vehicle that we are now embarking upon may provide crucial support to these future work sites.

Engineering Challenges in Implementing the Vision

Of course many of our engineering challenges directly relate to the objectives of the Vision for Space Exploration. As I said in a recent speech at the AIAA Space 2005 conference, President Bush committed this nation to a new direction in space, and set forth a fresh, clear mission for NASA. The President's directive gave all of us who are privileged to work in this business a challenge bold enough to last a lifetime. Indeed, it is a challenge to last several lifetimes.

We are undertaking a new program that will enable human beings to do things that have never been done before and see things that have never been seen before. If I were graduating from engineering school today, I would want to work at NASA because of these challenges.

Now throughout the agency's history, NASA has shown the ability to implement large-scale system engineering projects, and to conduct our systems engineering work in ways not previously thought possible. But what we have ahead of us represents a challenge significantly greater than what we faced when we first went to the moon.

Throughout the course of the International Space Station project, for example, we've learned a great deal about assembling large structures in space. We will need to draw on this knowledge as we assemble in low earth orbit the 500-metric ton spacecraft that will take a crew to Mars. We will also need to improve upon this knowledge, because we will never go to Mars if it takes us a decade or more to assemble the ship that is supposed to take us there.

The challenge only increases when we consider the things we have not yet done. In the future we need to develop systems to provide integrated launch vehicle system health monitoring. When a fighter pilot pushes a button to fire an air-to-air missile, the missile executes an automatic, built-in self test to inform the airplanes' fire control system, as to whether that missile is prepared to launch. And it does it in milliseconds. And if it is not ready, it automatically delegates to the next missile in line so the pilot doesn't have to think about it. We don't have that capability yet with NASA launch vehicles, although an air-to-air missile has every system in it that a launch vehicle has, and we will need to develop it. Or else we are always going to need to be using hundreds of people to conduct every launch that we execute. But we can't afford that.

While we are confident that we can build new launch and cargo carrying vehicles capable of carrying several metric tons into orbit, right now they are just concepts on computer screens. We will need our young engineers to take what we believe to be sound concepts and turn them into reality.

We have a lot of folks who are very good at solving well defined problems, at doing analysis, at running simulations. But this is not enough. Young engineers need to gain practical, real world experience, where theory meets the realities of hardware integration and flight test. This is especially challenging because although we have better tools today, opportunities for engineers to gain hardware experience are not as great as they were several decades ago. There are many reasons for this. I'll save that for another speech. But we at NASA need to get back to building hardware and flying spacecraft with greater regularity, and we are seeking to create those new opportunities.

In talking about the importance of American leadership in future space exploration, I frequently draw upon the history of earlier exploration, and emphasize how vital the commitment of nations like England, Portugal and Spain to mastery of the high seas was to the development of modern civilization as we know it. If the United States is to lead the way in the future, and help carry the principles and values of western philosophy and culture along on the inevitable outward migration of humanity into the solar system, and eventually beyond, we will need to develop a new kind of expertise based more upon some of the experiences in the history of exploration than we have seen in recent decades.

In particular, the spacecraft of the future, in the spirit of history's great sagas of land and ocean exploration, will have to be fueled and provisioned within trying weight limitations. They will have to protect crew from hazards such as radiation. We will have to be able to navigate, rendezvous and dock autonomously, and have the ability to be repaired several million miles away from home.

To conduct repairs, say in the vicinity of Mars, we may not be able to foresee every possible tool we will need to do the job. We will need to develop capabilities to create new tools onboard the spacecraft. We will need repair facilities capable of broad, general purpose manipulation, guided by software which is flexible, adaptable and reconfigurable depending on the task required. We don't have those tools today. We will never venture very far from home if we are forced to bring all of the required propellant and other supplies with us from the start. So we must learn to use local resources to reprovision our ships far from home. That is why we will challenge our engineers to develop rocket engines that can be fueled by a lox/methane mix, constituents that can be found in Mars' atmosphere. This requirement to live off the land will be crucial to our future in space, just as it was to Lewis and Clark and the Corps of Discovery as they made their way from St. Joseph, Missouri to the west coast and back from 1803 to 1806.

Until now, we have structured our space program to ensure that Mission Control in Houston is able to respond instantaneously to crews and assist them when problems arise on orbit. In the future, when crews are stationed on the moon for weeks and months at a time, or are on Mars, where it takes eight minutes to half an hour for a round trip message back to Earth, our crews will not have the luxury to wait for Houston or any other center to solve problems.

It's imperative that we move away from the mindset of "mission control" and move into a new era where our centers on the ground providing "mission support" to our intrepid explorers and their ships rather than mission control.

Our emphasis in the future will be on greater adaptability, flexibility and resilience and less so on roles, procedures and control dictated from the ground. And our engineering community will have to adapt to these requirements in their designs. Our ships will need to be smarter, and must work in tandem with their human crews.

We must think expansively about how our pioneers in the new worlds of the 21st century can grow food, construct shelters, supply power, and maintain their health on their own. These are the challenges that will require expertise in systems engineering, nanotechnology, nuclear engineering, bioengineering and human factors to name only a few. All human knowledge and skill will be needed to move beyond the Earth. Every discipline will play a role and every discipline will be challenged to expand the frontiers of its body of knowledge in order to contribute to America's space exploration vision. I know that most of you are like me and simply can't wait to get started.

In closing, I thank all of you for your dedication to American leadership in space, and for the opportunity to once again celebrate once again the tradition of excellence in engineering epitomized by the career of Moe Schneebaum and which will be so essential to our agency as we move to the next great challenge. Thank you.